Department of Electrical Engineering
Assignment
Date: 23/06/2020

Course Details

Course Title:	Instrumentation and Measurement	**Module:**	6^{th} (BE)
Instructor:		**Total Marks:**	50

Student Details

Name:		**Student ID:**	

Note: Draw neat diagrams where necessary. Assume missing details if required.

Q1.		A student has connected two voltmeters in series and have applied 500V across them. Both voltmeters have the same range of 0-300V. What will be their readings if their internal resistances are 25kΩ and 15 kΩ respectively?	**Marks 10** **CLO 2**
Q2.		A dynamometer type wattmeter has two current coils each having a resistance of 0.5Ω. Both of the coils are connected in parallel. The wattmeter voltage coil is connected to the supply side. The wattmeter shows a reading of 200W while the reading on the ammeter is 4A which is connected in series with the current coil of the wattmeter. Calculate the following parameters: a) Power dissipated in the wattmeter b) True load power c) Percentage error due to the connection of wattmeter	**Marks 10** **CLO 2**
Q3.	**(a)**	What is the difference between Kelvin's bridge and Wheatstone Bridge? Explain briefly.	**Marks 05** **CLO 3**
	(b)	Explain how the potential on the upper (top) node in a DC bridge is equal to the potential on the lower (bottom) node?	**Marks 05** **CLO 3**

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Q1

Ans

Given Data:

Two voltmeter range = 0 — 300V

~~Resistor~~ R_1 = 25 KΩ

R_2 = 15 KΩ

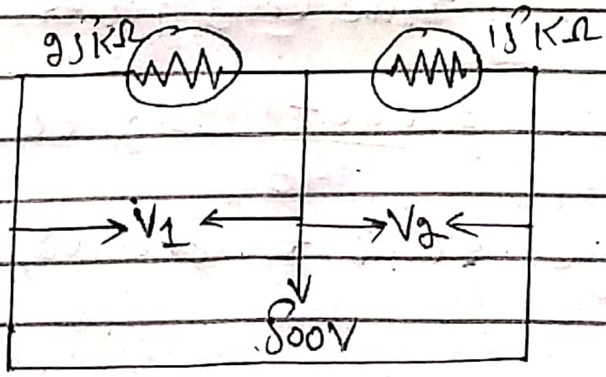
and The Total voltage is VT = 500V

Required

voltage reading in 1st voltmeter = V_1 = ?

voltage reading in 2nd voltmeter V_2 = ?

Diagram:



Solution.

we used voltage divider rule the reading of the Two voltmeter:

(1) $$V_1 = \frac{R_1}{R_1 + R_2} \times V$$

$$V_1 = \frac{25K\Omega}{25K\Omega + 15K\Omega} \times 500$$

$$V_1 = 312.5V. \text{ Ans}$$

(2) $$V_2 = \frac{R_2}{R_2 + R_1} \times V$$

$$V_2 = \frac{15K\Omega}{15K\Omega + 25K\Omega} \times 500$$

$$V_2 = 187.5V. \text{ Ans}$$

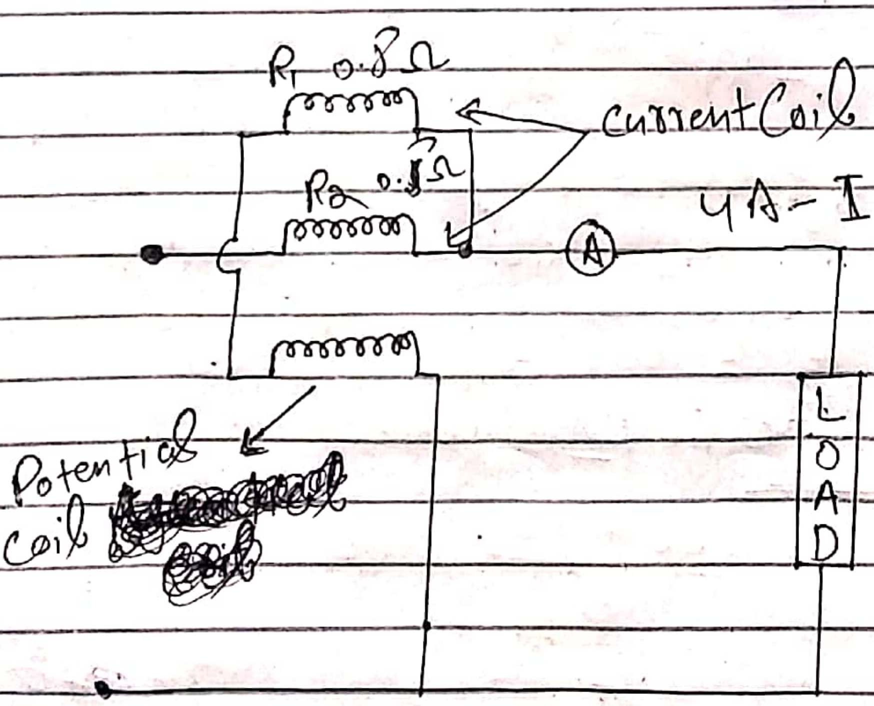
Q9

Given Data.

$R_1 = 0.5\,\Omega$, $R_2 = 0.8\,\Omega$
Power = 200W
I = 4A

Required.

(a) Power Desipated in the wattmeter.
(b) True Load power.
(c) Percentage error dues to the connection of wattmeter.



Solution.

Resistance of Current Coils

$$R_C = \frac{R_1 R_2}{R_1 + R_2} = \frac{0.5 \times 0.5}{0.5 + 0.5}$$

$$R_C = \frac{0.25}{1} = 0.25\Omega$$

(a)

Power Dessipated in wattmeter $= I^2 R_C$

$$I^2 R_C = ((4)^2 \times 0.25)$$

$$= 16 \times 0.25$$

$$I^2 R_C = 4W.$$

(b) True Load Power $= 200 - 4$

$= 196W$

(c) % error $= \frac{P - \text{True Load}}{\text{True Load power}} \times 100$

$$= \frac{200 - 196}{196} \times 100$$

Percentage error $= 2.0408$

Q3 (a)

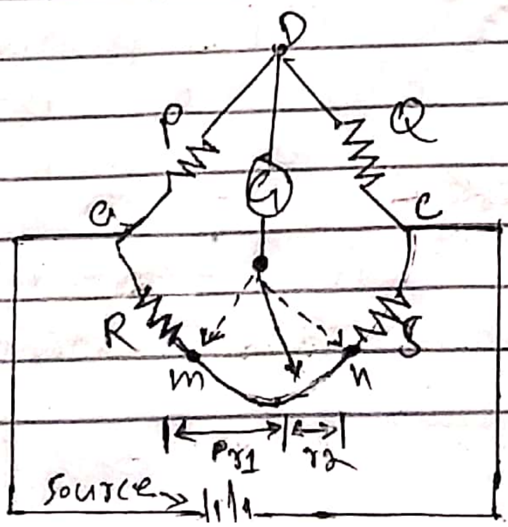
Ans

Kelvin's Bridge:-

This brigdge is modification of wheatstone bridge and is used to measure low resistances very accuately.

→ when we are implementing wheatstone bridge in the laboratory, we connect all the resistances through connecting wires.

→ Hence, these connecting wires also have some resistance and in order to measure it, we will use Kelvin's bridge.



Principle of Kelvin Bridge.

Working of Kelvin Bridge

A current is passed between the current terminals, but the volt drop across the resistor is measured at the potential terminals ... To measure such resistances requires a bridge.

Uses of Kelvin's bridge

Kelvin is also used for pinpointing color temperature and is typically used lighting. In a lighting application.

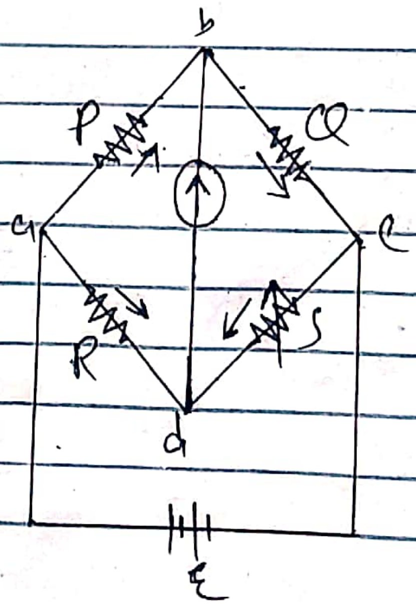
Wheatstone bridge

A wheatsotone bridge is an electrical circuit used to measure an unknown electrical resistance by balancing two legs of a bridge circuit, one leg of which includes the unknown component.

Difference between Kelvin's bridge and wheatstone bridge.

Wheatstone bridge measure electrical resistance by balancing a bridge circuit. The circut has two legs, of which one has two legs, of which one contains the unknown resistance of value between 1ohm to 10 ohms. Apart from resistance, this setup can also measure impedance, Capacitance and inductance.

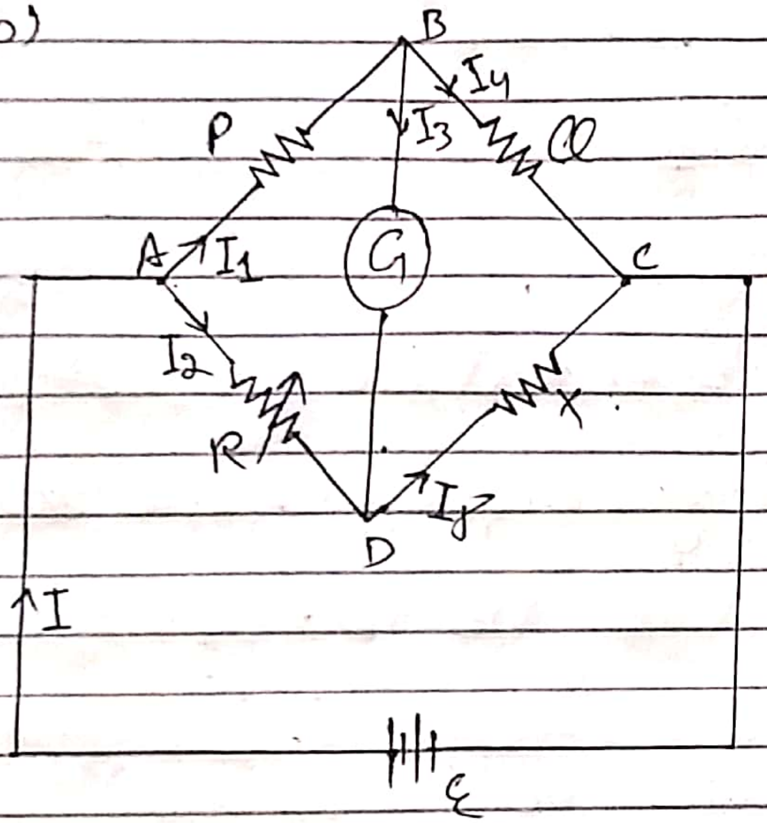
Kelvin bridge is more advanced and helps in measuring resistances less than 1 ohm. However, it has two more resistors than the wheatstone bridge.



Wheatstone Bridge Diagram.

Q3(b)

Ans



when P & Q are known resistor.
R is a variable resistor.
X is unknown resistor.
E is DC power supply.

⇒ Now in order to find the value of unknown resistor (X) we have to make the defection of galvanometer equals to zero i.e is $I_3 = 0A$.

→ This condition is called balance condition of bridge

when $I_3 = 0A$
$I_5' = I_2$
& $I_4 = I_1$

$\because V = IR$

Also $V_{AB} = V_A - V_B = I_1 P$ — (1)

$V_{BC} = V_B - V_C = I_1 Q$ — (2)

$V_{AD} = V_A - V_D = I_2 R$ — (3)

$V_{DC} = V_D - V_C = I_2 X$ — (4)

at balance condition when $I_3 = 0A$ potential difference b/w Point B and D is Zero i.e

$V_B = V_D$ and it is proved below:-
As we know that $V_{BD} = V_B - V_D = I_3 G$
So ~~$V_{BD} = V_B - V_D$~~ ÷
$V_{BD} = I_3 G$
$V_{BD} = (0)(G)$
$V_{BD} = 0V$
or $V_B - V_D = 0$

or $\underline{\underline{V_B = V_D}}$ proved.

Q4(a)

AC Energy meter works due to the involement of two alternating magnetic fields produced by AC quantities (voltage and current respectively) that interacts with an aluminium disk causing eddy current to induced in the disk. Due to this eddy current and preexisting magnetic field, disk experiences a force with causes it to rotate and increment the reading in proportion to the amount of energy consumed (in Units or KWh both are Same). In DC such induction effect and eddy current are nor produced, So the Same energy meter cannot measure the energy consumed by and DC circuit until unless you convert the DC to AC then put it through the energy meter and again Convert it to DC and then Supply to the DC load.

x —— x —— x —— x —— x —— x — x

Q4 (b)

It should be noted the the $\theta = 0°$

(for example Fluxes are in phase) then deflecting Torque is zero or no Torque can be reduced.

Torque will be Maximum when $\theta = 90°$

The Deflection Torque is the same at every instant since ϕ_m, ϕ_p m and Q are fixed for a given condition.

The direction of deflecting Torque depends upon which Flux is leading the other.

Q5(a)

Ans: Electromagnets Called "shunt" mgnet and "series" magnet

electromagnets called "shunt" magnet and "Series" magnet of laminated construction.
A coil having large number of turns of fine wire is wound on the middle limb of the Shunt magnet.

This Coil is Known as "Pressure or voltage" coil and is connected across the Supply mains.

and series magnetic is wound with a wire of few Turns as Connected in series with load so that it Carries the Load Current.

The coil of the olgnetic is highly non inductive.

Q5(b) significance of Meter Constant in an Energy meter?

Ans Energy Meter

Energy Meter Constant is the amount of KWH used in its low voltage circuit for each revolution of the induction disc.

Calcalation:

typical industrial 3-Phase Energy Meter which is feed by a Suitable Current Transformer [CT] and potential Transformer [PT]

To calculate the EMC: If it is given that No. of Revolutions

Per KWh then, MC is inverse of this no. for example, Let's Say for a certain Energy meter, No Rev./KWH is given as 4000 then MC = 1/4000.

If the No of Rev. per KWH is given as a very small No. like 0.06 or 0.16 etc. then it refers to KWH value in Primary circuit. That is, 1 KWH value passes in HV circuit for given amount of Rev. To calculate MC in such cases, invert such No. and then divide by CT and PT ratio.

P.T.O

Energy meter is Constant is shown on the meter nameplate.
A constant "Kh = 7.2"
means that for each revolution

of the disk, 7.2 watt-hours has been used (constants will very with different meters).

To determine how much electrical energy is used by Counting meter-disk revolutions, Proceed as follows: 1

Principle of Induction.